ELGAR/Sorensen

POWERFUL SOLUTIONS

SORENSEN

M9C User's Manual

SORENSEN Division of ELGAR
9250 Brown Deer Road
San Diego, CA 92121

M9C Series
User's Manual

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1.0 FEATURES, FUNCTIONS, and SPECIFICATIONS

1.1 Introduction

The M9C interface card enables you to operate your Sorensen power supplies from a computer via the IEEE-488.2 GPIB or RS-232 interface, allowing full remote programming control and monitoring of your power supply. The M9C is compatible with both the M9A (which it replaces) and SCPI languages. Multiple source control is supported by the M9C allowing control of up to 30 auxiliary power supplies with the Extended Interface Bus.

1.2 Features and Functions

Features

- 12-bit programming and 12-bit readback of voltage and current
- Programmable over voltage protection with reset
- IEEE-488.2 and SCPI compliant command set
- User-programmable signals including Local/Remote Sense, External Polarity, and Disconnect Relay Drive
- Foldback in Constant-Voltage or Constant-Current mode with reset
- Voltage Ramp and Current Ramp functions
- Field-upgradable firmware via RS-232
- Attachment of up to 30 supplies via EIB interface with the M85 option
- Soft Calibration
- Rear panel IEEE-488.2 and RS-232 control interface
- Rear panel User Control Signal interface
- Rear panel configuration switch

Programmable Functions

- Output voltage and current
- Soft limits for voltage and current
- Over voltage protection
- Output enable/disable
- Maskable fault interrupt
- Hold and trigger
- External relay control
- Full calibration

Readback Functions

- Actual measured voltage and current
- Voltage and current settings
- Soft voltage and current limits
- Over voltage protection setting
- Status and Accumulated Status registers
- Programming error codes
- Fault codes
- Manufacturer, power supply model, and firmware version identification

1.3 Specifications

(SUBJECT TO CHANGE WITHOUT NOTICE)

Programming Resolution

Voltage: 0.03% of full scale
Current: 0.03% of full scale
Overvoltage
Protection: 0.03% of full scale (full scale is 120% of max output voltage.)

Programming Accuracy

Voltage: ± (0.10% + 0.1% of maximum output voltage)
Current: ± (0.1% + 0.4% of maximum output current)*
Overvoltage
Protection: ± (0.5% + 0.5% of max output voltage)

Readback Resolution

Voltage and Current: ± 0.03% of full scale

Readback Accuracy

Voltage: ± (0.10% + 0.15% of full scale output voltage)
Current: ± (0.1% + 0.4% of full scale output current)*

* After 30 minutes operation with fixed line, load, and temperature.

2.0 CONFIGURATION

The M9C is installed in the supply at the factory. Use the Setup Procedure described below to configure the installed M9C for your system and application.

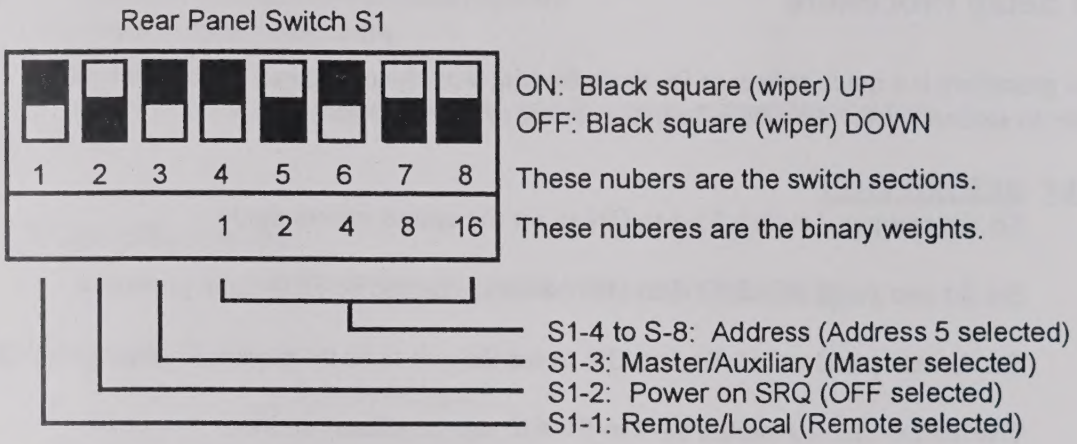
2.1 Setup Procedure

This procedure is a quick reference for those familiar with the configuration requirements. Refer to section 2.2 for detailed information of the rear panel switch S1.

STEP	DESCRIPTION
1	Set the rear panel switch S1-1 to ON to set the unit to remote mode.
2	Set the rear panel switch S1-2 to OFF to set the unit to no SRQ upon power-on.
3	Set the rear panel switch S1-3 to ON to set the unit to be the master device.
4	Use the rear panel switches S1-4 to S1-8 to set the primary address. Select a unique primary address to identify the power supply to the computer controller in your system.
5	Connect the IEEE-488.2 or the RS-232 bus to the supply.
6	Connect power to the unit and power-on the unit. Verify that the green REMOTE LED on the front panel is on.
7	Configure the controller to match the supply identification and configuration using one of the available programs such as IBCONF from National Instruments for GPIB or set RS-232 baud rate to 19200, 8 data bits, no parity, and 1 stop bit.
8	Test the link by communicating with the supply: e.g.: *IDN? This command string returns the power supply model and firmware version. This command does not affect the output.

2.2 Rear Panel Configuration Switch

The DIP switch S1 is accessible from the rear panel to allow configuration of the supply with the installed M9C for the user's particular system and application.


Rear Panel Switch S1
1 2 3 4 5 6 7 8
1 2 4 8 16
ON: Black square (wiper) UP
OFF: Black square (wiper) DOWN
These nubers are the switch sections.
These nuberes are the binary weights.
S1-4 to S-8: Address (Address 5 selected)
S1-3: Master/Auxiliary (Master selected)
S1-2: Power on SRQ (OFF selected)
S1-1: Remote/Local (Remote selected)

2.2.1 Remote/Local Selection

Set the rear panel Remote/Local switch S1-1 to select remote or local operation.

REMOTE/LOCAL SWITCH S1-1	
Switch Position	**Description**
ON	Remote operation selected. Front panel control is disabled. Control is accessible only thru GPIB or RS-232.
OFF	Local operation selected. Front panel control is enabled. Unit will switch to remote operation upon the first GPIB or RS-232 command.

Powering up in remote mode will result in the following operating conditions.

REMOTE MODE POWER-ON CONDITIONS	
Condition	**Default**
Voltage	0.0 Volts
Current	0.0 Amps
Soft Voltage Limit	Model maximum voltage
Soft Current Limit	Model maximum current
OVP Trip Voltage	Model maximum voltage + 10%
Delay	0.5 seconds
Foldback Protection	OFF
Output	ON
Hold	OFF
Unmask	NONE
Service Request Capability	OFF

2.2.2 Power-On GPIB Service Request (PON SRQ) Selection

Set the rear panel PON SRQ switch S1-2 to ON to cause a GPIB service request to be sent to the computer controller when the supply is turned on. The front panel SRQ LED will also turn on. You may clear the service request and turn off the SRQ LED by issuing a serial poll.

POWER-ON GPIB SERVICE REQUEST (PON SRQ) SWITCH S1-2	
Switch Position	**Description**
ON	Power-On SRQ selected
OFF	No Power-On SRQ selected

Refer to the manufacturer's manual for your specific GPIB controller card for further details on serial polling.

2.2.3 Master/Auxiliary Selection

For the M9C, set the rear panel Master/Auxiliary switch S1-3 to ON to configure the supply to be the master. The address selection for a master is the GPIB address (1-30). For the M85, set the supply to be an auxiliary unit. The address selection for an auxiliary unit is the channel number of that device (2-31). Refer to section 2.2.4 for more details regarding address selection.

MASTER/AUXILIARY SWITCH S1-3	
Switch Position	**Description**
ON	Master unit (M9C only)
OFF	Auxiliary unit (M85 only)

2.2.4 Address Selection

The address selection is binary with switch S1-4 as the LSB and S1-8 as the MSB. The rear panel switch illustration shown in section 2.2 shows the address selection 00101 in binary (5 decimal).

The address selection for a master unit is the GPIB address of that device (1-30). The address selection for an auxiliary unit is the channel number of that device (2-31). The channel selections 0 and 1 are invalid for an auxiliary device because SCPI reserves channel 0 as the global channel to address all channels and channel 1 as the default master channel to address the master unit.

ADDRESS SWITCH S1-4 to S1-8	
Switch Position	**Description**
ON	1
OFF	0

2.3 External User Control Signal Connector

The 8-pin connector located at the rear panel provides external auxiliary control signals to increase the user's operating control of the supply. The mating receptacle is the Molex 43025-0800 with 8 female terminals 43030-0003. The terminals accomodate wire sizes from #20 - #24.

The relay outputs when active connect POLARITY, SENSE, and ISOLATION pins to the relay COMMON pin. The relays are rated at 380VAC/125VDC @ 5A.

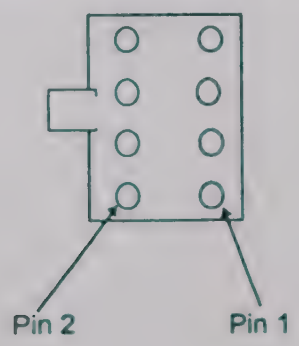
Any change in output (voltage, current, etc.) initiated by the user from the RS-232 or GPIB interface will cause a 10ms synchronization pulse to be generated at the rear panel User Control Signal Connector pin 8 of the master unit.

EXTERNAL USER CONTROL SIGNAL CONNECTOR PINOUT	
Pin	**Description**
1	FOLDBACK output signal, open collector. Asserted when in foldback mode.
3	FAULT output signal, open collector. Asserted when a fault is recorded in the fault register.
6	POLARITY output signal, relay. Asserted when a negative voltage is programmed. (e.g. SOURce:VOLTage -5.0)

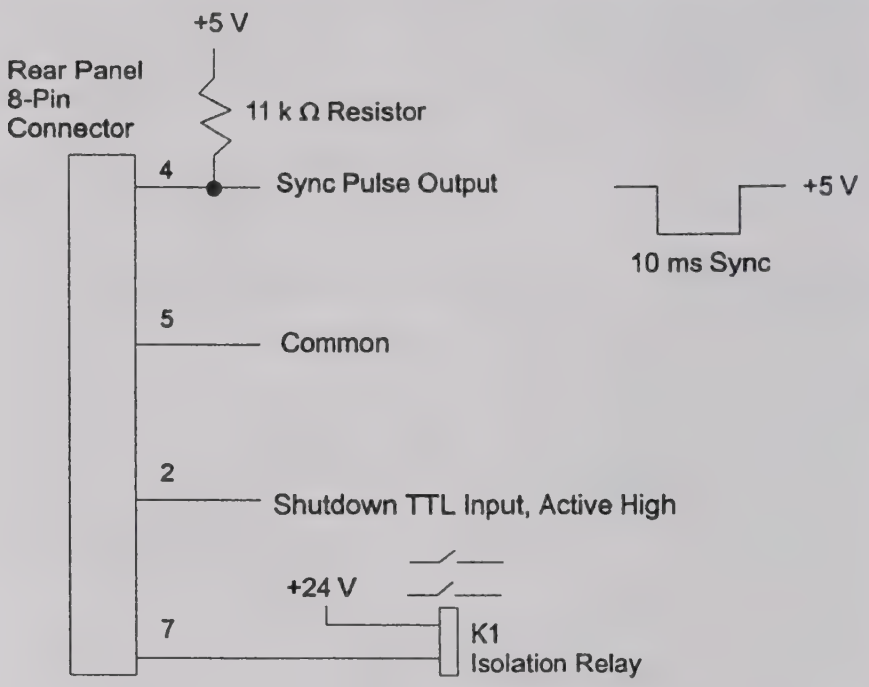
Pin	**Description**
7	ISOLATION output signal, relay. Asserted when the output relay is programmed OFF. (e.g. OUTPut:ISOlation OFF)
8	SENSE output signal, relay. Asserted when the sense relay is programmed OFF. (e.g. OUTput:SENse OFF)
2	SHUTDOWN TTL input signal, active low. Allows the user to immediately shutdown the unit by a TTL input signal.
5	GND
4	SYNC output signal, open collector. Pulsed when a change in the output occurs.

CABLE ASSEMBLY COLOR CODES	
Pin	**Wire Color**
1	Brown
2	Red
3	Orange
4	Yellow
5	Green
6	Blue
7	Black
8	White

EXTERNAL USER CONNECTOR DESIGNATION



Example illustration of open collector, TTL input, & relay output circuits:



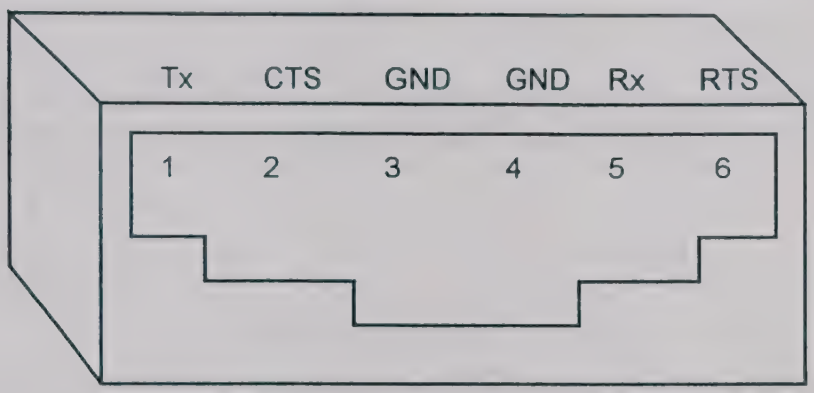
WARNING

Please refer to the power supply manual for further information. It is not recommended that any of the sense, polarity, or isolation signals be activated if the power supply output is greater than zero volts or zero amps.

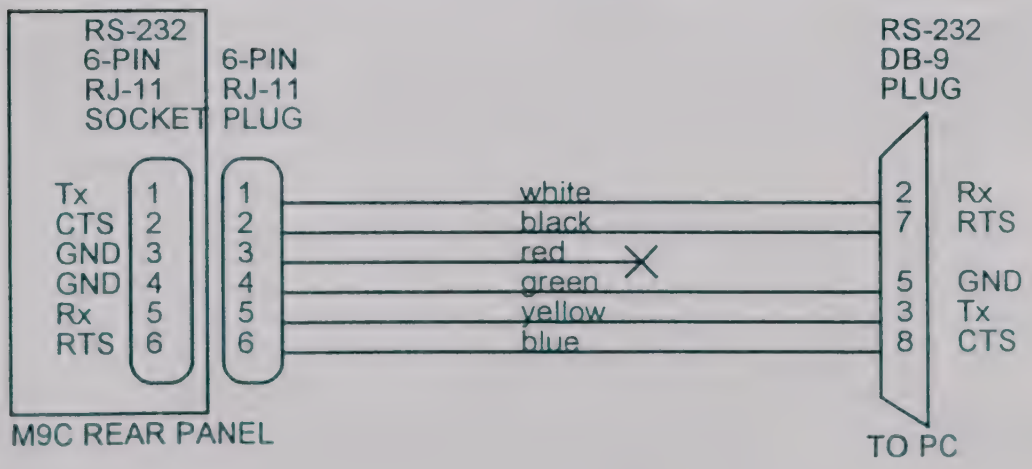
2.4 Remote programming via RS-232

The M9C's RS-232 interface operates at 19.2Kbaud with 8 data bits, no parity, and 1 stop bit. All M9C commands are supported at the RS-232 interface with the exception of the Service Request (SRQ) function which is a GPIB-specific function requiring the dedicated Service Request line of the IEEE-488.2 interface. In this case, the SRQ function has no effect. The RS-232 interface is accessible thru the rear panel 6-pin RJ-11 connector J1.

RS-232 REAR PANEL RJ-11 CONNECTOR PINOUT



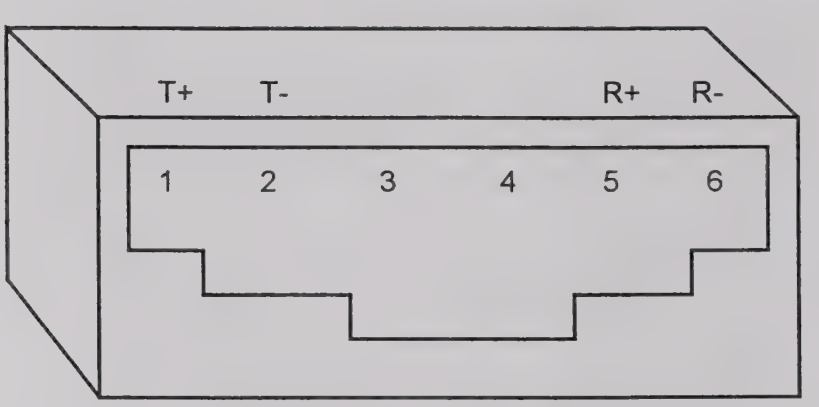
M9C-TO-PC RS-232 CONNECTION (RJ-11 TO DB-9)



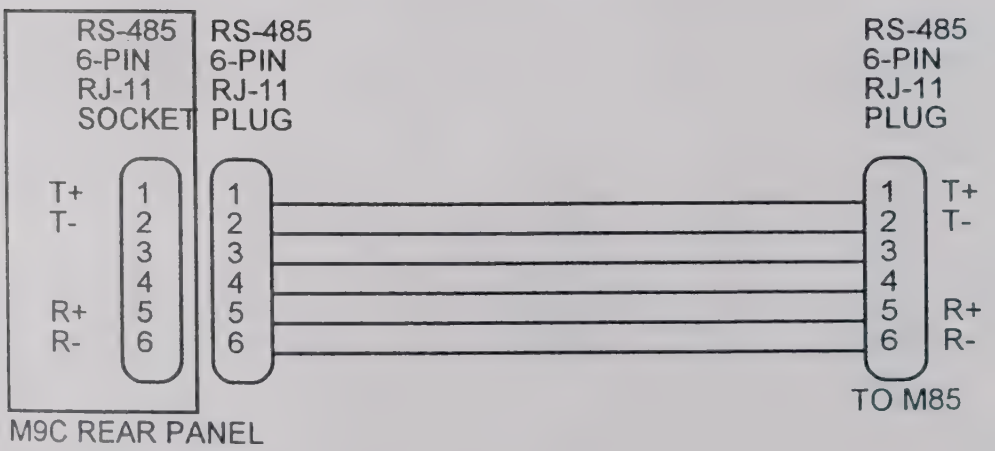
2.5 Extended Interface Bus (EIB) with the M85 option

The M85 option is an auxiliary controller used in conjunction with the M9C to provide multiple sources controlled by a single GPIB address or via a single RS-232 connection. Up to 30 EIB controllers can be attached to a single M9C via the RS-485 bus connection at the rear panel of the M9C. The EIB is accessible thru the rear panel 6-pin RJ-11 connector J2.

RS-485 REAR PANEL RJ-11 CONNECTOR PINOUT:



M9C-TO-M85 EIB CONNECTION (RJ-11 TO RJ-11):



3.0 IEEE 488.2 and SCPI COMMAND OPERATION

3.1 Introduction

The following sections describe the operation of the M9C by remote programming using the M9C IEEE488.2 and SCPI command set. The M9C IEEE488.2 and SCPI command set of programming, query, and status commands allow control of the power supply.

3.2 IEEE-488.2 Register Definitions

The M9C supports the IEEE-488.2 and SCPI 1995.0 status reporting data structures. These structures are comprised of status registers and status register enable mask pairs. The following sections describe these pairs.

3.2.1 Status Byte

The Status Byte status register can be read by the *STB? command or by issuing a GPIB serial poll. Either operation will clear the contents of the Status byte. The Status Byte status register will also be cleared by the *CLS command.

The M9C can be configured to request service from the GPIB controller by setting the appropriate bits in the Service Request Enable Register (SRE). The SRE register has the same bit pattern as the Status Byte. It is modified using the *SRE <mask> command and read with the *SRE? command. For example, if the SRE register is set to 0x10 (MAV), when the M9C unit has a message available, the Status Byte register will contain 0x50 (RQS and MAV) and the SRQ line of the GPIB bus will be asserted to indicate a request for service.

STATUS BYTE		
Bit	**Hex Value**	**Description**
0	0x01	Not Used
1	0x02	Protection Event Status flag. Indicates the selected protection event occurred.
2	0x04	Error/event queue message available. Set when any error/event is entered in the System Error Queue. It is read using the SYSTem:ERRor? query.
3	0x08	Questionable Status flag. Indicates the quality of the current data being acquired. This bit is not used.
4	0x10	Message available (MAV). Indicates a message is available in the GPIB output queue. Cleared after the GPIB output buffer is read.
5	0x20	Standard Event Status Register (ESR). Summary bit for the ESR. Set when any of the ESR bits are set and cleared when the ESR is read.
6	0x40	Request Service flag (RQS) for serial polling or Master Summary Status (MSS) in response to *STB? If service requests are enabled (with the *SRE command) this bit represents the RQS and will be sent in response to a serial poll, then cleared. If RQS is not enabled, the bit represents the MSS bit and indicates the device has at least one reason to request service. Even though the device sends the MSS bit in response to a status query (*STB?), it is not sent in response to a serial poll. It is not considered part of the IEEE-488.1 Status Byte.
7	0x80	Operation Status flag. Indicates the current operational state of the unit. This bit is not used.

3.2.2 Standard Event Status Register (ESR)

The Standard Event Status Register (ESR) can be read by the *ESR? command. Reading this register or the *CLS command will clear the ESR. Bits in the ESR will only be set when the corresponding bit in the Standard Events Status Enable Register is set. Use the *ESE <mask> to set bits, and the *ESE? to read this register. To configure the DCS Series M9C to generate GPIB service requests based on the ESR, both the Standard Event Status Enable Register and the Service Request Enable Register must be programmed.

STANDARD EVENT STATUS REGISTER		
Bit	**Hex Value**	**Description**
0	0x01	Operation Complete.
1	0x02	Request Control - not used.
2	0x04	Query Error.
3	0x08	Device Dependent Error.
4	0x10	Execution Error (e.g. range error)
5	0x20	Command Error (e.g. syntax error)
6	0x40	User Request - not used.
7	0x80	Power On

3.2.3 Protection Event Status Register

The Protection Event Status Register can be read by the STATus:PROTection:EVENt? command. Reading this register or the *CLS command will clear the Protection Event Status Register. Bits in the Protection Event Status Register will only be set when the corresponding bit in the Protection Event Status Enable Register is set. Use the STATus: PROTection: ENABle <mask> command to set and the STATus:PROTection:ENABle? query to read this register. To configure the M9C to generate GPIB service requests based on the Protection Events Status Register, both the Protection Event Status Enable Register and the Service Request Enable Register (*SRE) must be programmed.

PROTECTION EVENT STATUS REGISTER		
Bit	**Hex Value**	**Description**
0	0x01	Constant voltage operation
1	0x02	Constant current operation
2	0x04	Not used
3	0x08	Overvoltage protection tripped
4	0x10	Overtemperature protection tripped
5	0x20	Supply external shutdown active
6	0x40	Foldback mode operation
7	0x80	Remote programming error

3.2.4 Operation Status and Questionable Status Registers

The Operation Status and Questionable Status Registers will always return 0 when queried. The Operation Status Enable and Questionable Status Enable Registers can be programmed and queried to allow SCPI compatibility but have no effect on the Operation Status and Questionable Status Registers.

3.2.5 Error/Event Queue

The M9C maintains an Error/Event Queue as defined by SCPI. The queue holds up to 10 error and events. It is queried using the SYSTem:ERRor? command which reads in a First In/First Out (FIFO) manner. The read operation removes the entry from the queue. The *CLS command will clear all entries from the queue.

The following error codes are defined in the SCPI 1995.0 specification and are supported by the M9C. Error codes are in the range of [-32768, 32767]. SCPI reserves the negative error codes and 0, while error codes greater than 0 are device specific errors.

SCPI ERROR CODES	
Error Code	**Description**
0	**No error** The error queue is empty.
-102	**Syntax error** An recognized command or data type was encountered.
-108	**Parameter not allowed** More arguments than expected were received.
-151	**Invalid string data** Incorrect password. Manufacturer, model, or serial number string were more than 16 characters. Invalid mnemonic.
-161	**Invalid block data** The expected number of data values was not received.
-200	**Execution error** An error/event number in the range [-299,-200] indicates that an error has been detected by the instruments execution control block. The occurrence of any error in this class shall cause the execution error bit (bit 4) in the Event Status Register to be set. An execution error can be the result of: • A <program data> element out of range, such as programming 35 volts in a 33 volt device. • A command could not be executed due to the current condition of the device.
-203	**Command protected** Attempted to store calibration values to EEPROM without unlocking.
-221	**Settings conflict** Attempted to set output less than soft limits or to set soft limits less than output.
-222	**Data out of range** Parameter exceeded range of valid values.
-225	**Out of memory** There is not enough memory to perform the requested operation.

Error Code	Description
-241	**Hardware missing** A legal command or query could not be executed because the option is not installed.
-284	**Program currently running** A legal command or query could not be executed because a function is currently running.
-292	**Referenced name does not exist**
-293	**Referenced name already exists**
-316	**Checksum error**
-330	**Self-test failed** A self-test failure has occurred.
-340	**Calibration failed** Error during calculation of calibration values occurred.
-350	**Queue overflow** The error queue can contain up to 10 entries. If more than 10 error/event conditions are logged before the SYSTem:ERRor? query, an overflow will occur; the last queue entry will be overwritten with error -350. When the queue overflows, the least recent error/events remain in the queue and the most recent error/events are discarded.
-360	**Communication error** Communications to a channel was disrupted.

3.2.6 Serial Poll Operation

Performing a serial poll will not modify the Status Byte other than to clear the RQS (bit 6) for an M9C requesting service. Queries affecting the Status Registers and subsequent serial poll are described below:

- *STB? clears the Status Byte
- *ESR? clears the ESR and bit 5 of the Status Register
- SYSTem:ERRor? clears bit 2 of the Status Register if the queue is empty

3.3 IEEE-488.2 and SCPI Conformance Information

The M9C conforms to all specifications for devices as defined in IEEE-488.2 and complies with SCPI command syntax version 1995.0. Confirmed Commands are those commands which are approved commands in the SCPI 1995 Specification, Volume 2: Command Reference. They are denoted by a "C" in the "SCPI" column. Any commands that are not Confirmed Commands have been submitted to the SCPI Consortium and are labeled as Not Approved denoted by a "N".

3.3.1 Parameter Definitions

PARAMETER DEFINITIONS	
Type	**Valid arguments**
<boolean>	"ON" or 1. "OFF" or 0.
<NR1>	The data format <NR1> is defined in IEEE-488.2 for integers. Zero, positive and negative integer numeric values are valid data.
<0+NR1>	Zero and positive integer numeric values.
<-NR1>	Negative integer numeric values.
<NRf>	The data format <NRf> is defined in IEEE-488.2 for flexible Numeric Representation. Zero, positive and negative floating point numeric values are some examples of valid data.
<0+NRf>	Zero and positive floating point numeric values.
<-NRf>	Negative floating point numeric values.
<string>	Characters enclosed by single or double quotes.

3.3.2 Units

The DCS Series M9C will accept the following units as suffixes to numeric values:

UNITS	
Type of Unit	**Valid suffix**
Voltage	"VOLTS" or "volts", "V" or "v", "MV" or "mv"
Current	"AMPS" or "amps", "A" or "a", "MA" or "ma"
Time	"SEC" or "sec", "S" or "s", "MS" or "ms", "MIN" or "min"
Frequency	"HZ" or "hz"

The default units are VOLTS, AMPS, SEC, & HZ. For example, "SOUR:VOLT 1" programs 1 volt. To program in units of millivolts, type "SOUR:VOLT 1 MV".

3.3.3 Conventions

SCPI uses the conventions where optional commands and parameters are enclosed by "[]". Additionally the shorthand version of a command is indicated by capital letters. The optional parameter "[n]" selects the channel number (power supply) being commanded. If "[n]" is not specified, the default master channel 1 is automatically selected. Channel 1 selects the master unit and channels 2-31 select an auxiliary unit attached with the M85 option. Selecting the global channel 0 is allowed only for the TRIGgerred[n] commands.

For example,

SOURce[n]:VOLTage[:LEVel][:IMMediate][:AMPLitude] 120.0

can be written as

SOURce[n]:VOLTage 120.0 // for any channel

or

SOUR:VOLT 120.0 // for default master channel 1

3.3.4 Queries

The query syntax is identical to the command syntax with a "?" appended. For example, to query the programmed voltage, send the string: SOURce:VOLTage?. A subsequent device read will return a value such as "33.000". All queries are terminated with a carriage return and line feed (0x0D 0x0A) for those GPIB controllers that require termination characters. When the M9C has nothing to report, its output buffer will contain two ASCII characters: a carriage return and linefeed (in decimal the values are: <13><10>).

3.4 IEEE-488.2 Common Command Subsystem

The following commands are common to all SCPI instruments and declared mandatory by IEEE-488.2. In the following table, the M9C will be defined as the "device" on the GPIB bus.

Command	Description
*CLS[n]	Clears all status reporting data structures including the Status Byte, Standard Event Status Register, and Error Queue. Enable masks are not cleared.

Command	Description
*ESE[n] <0+NR1>	Sets the value of the Standard Event Status Enable Register which determines which bits can be set in the Standard Event Status Register. See section on Standard Event Status Register for valid values.
*ESE[n]?	Returns the integer value of the Standard Event Status Enable Register. See section on Standard Event Status Register for valid values. **Response:** <0+NR1>
*ESR[n]?	Returns the integer value of the Standard Event Status Register. The ESR and the Status Byte ESR bit are cleared. See section on Standard Event Status Register for valid values. **Response:** <0+NR1>
*IDN[n]?	Returns the device identification as an ASCII string. **Response:** <Manufacturer>, <model>, <serial number>, <DCI firmware version> <AI firmware version> **Example:** Sorensen, DCS33-33, B90000-0, 1.00,1.00
*OPC[n]	Enables the Operation Complete bit of the Standard Events Status Register to be set when all pending operations are complete. See section on Standard Event Status Register.
*OPC[n]?	Returns the integer value "1" when all pending operations are complete. See section on Standard Event Status Register. **Response:** <0+NR1>
*RST[n]	Resets the supply to its Power ON (PON) state. Clears all status reporting data structures including the Status Byte, Standard Event Status Register, and Error Queue. Enable masks are not cleared.
*SRE[n] <0+NR1>	Sets the value of the Service Request Enable Register which determines which bits in the Status Byte will cause a service request from the device. See section on Status Byte for valid values.
*SRE[n]?	Returns the integer value of the Service Request Enable Register. See section on Status Byte for valid values. Values range from 0-63 or 128-191. **Response:** <0+NR1>

Command	Description
*STB[n]?	Returns the integer value of the Status Byte with bit 6 representing the Master Summary Status (MSS) instead of RQS. The MSS bit acts as a summary bit for the Status Byte and indicates whether or not the device has at least one reason to request service based on the MAV and the ESR bits. The Status Byte is cleared. See section on Status Byte for valid values. Values range from 0-255. **Response:** <0+NR1>
*TST[n]?	Sets the device to execute an internal self-test and return the integer value of the results. Value of "0" indicates no errors. **Response:** <0+NR1>
*WAI[n]	Sets the device to wait until all previous commands and queries are complete before executing commands following the *WAI command.

3.5 CALIBRATION SCPI Command Subsystem

See section 4.0 for calibration procedures.

3.5.1 CALIBRATION SCPI Command Summary

CALibrate[n]
:DATA <NRf><NRf><NRf><NRf><NRf><NRf><NRf><NRf><NRf><NRf>
:INITial
:CURRent <0+NRf>
:VOLTage
[:AMPLitude] <NRf>
:PROTection <NRf>
:LOCK
:MEASure
:CURRent
:ADC?
:CALCulate
:GAIN <NRf>
:OFFSet <NRf>
:POINt <1|2> <0+NRf>
:VOLTage
:ADC?
:CALCulate
:GAIN <NRf>

```
                :OFFSet <NRf>
                :POINt <1|2> <NRf>
:OUTPut
        :CURRent
                :CALCulate
                :DAC <0+NR1>
                :GAIN <NRf>
                :OFFSet <NRf>
                :POINt <1|2> <NRf>
        :VOLTage
                :CALCulate
                :DAC <0+NR1>
                :GAIN <NRf>
                :OFFSet <NRf>
                :POINt <1|2> <NRf>
                :PROTection
                        :CALCulate
                        :DAC <0+NR1>
                        :GAIN <NRf>
                        :OFFSet <NRf>
:STORe
:UNLock <string>
```

3.5.2 CALIBRATION SCPI Command Reference

Command	Description	SCPI
CALibrate[n]	Calibration subsystem. n = 1-31. The default channel is 1.	C
:DATA <NRf><NRf><NRf> <NRf><NRf><NRf> <NRf><NRf><NRf> <NRf>	Sets the values of the ten floating point calibration constants: 1) output voltage DAC gain 2) output voltage DAC offset 3) output current DAC gain 4) output current DAC offset 5) output voltage protection DAC gain 6) output voltage protection DAC offset 7) voltage measurement ADC gain 8) voltage measurement ADC offset 9) current measurement ADC gain 10) current measurement ADC offset Values are separated by space or comma.	N
Command	**Description**	**SCPI**
:INITial		N

:CURRent	Sets the power-on default value of current.	N
:VOLTage		N
[:AMPLitude] <NRf>	Sets the power-on default voltage.	N
:PROTection <NRf>	Sets the power-on default value of the over voltage protection.	N
:LOCK	Disables access to the non-volatile memory. Prevents attempts to store calibration values.	N
:MEASure		N
:CURRent		
:ADC?	Returns the integer value of the A/D for the current measurement.	N
:CALCulate	Calculates the value of the gain and offset for current measurements.	N
:GAIN <NRf>	Sets the value of the gain for current measurements.	N
:OFFSet <NRf>	Sets the value of the offset for current measurements.	N
:POINt <1|2> <0+NRf>	Sets the current measurement calibration point (1 or 2). The actual output current is measured with the external meter.	N
:VOLTage		N
:ADC?	Returns the integer value of the A/D for the voltage measurement.	N
:CALCulate	Calculates the value of the gain and offset for voltage measurements.	N
:GAIN <NRf>	Sets the value of the gain for voltage measurements.	N
:OFFSet <NRf>	Sets the value of the offset for voltage measurements.	N
:POINt <1|2> <NRf>	Sets the voltage measurement calibration point (1 or 2). The actual output voltage is measured with the external meter.	N
:OUTPut		N
:CURRent		N
:CALCulate	Calculates the value of the gain and offset for output current.	N
:DAC <0+NR1>	Sets the output of the output current D/A converter. The value range is 0 - 4095.	N
:GAIN <NRf>	Sets the value of the gain for the output current.	N
Command	**Description**	**SCPI**
:OFFSet <NRf>	Sets the value of the offset for the output current.	N

:POINt <1|2> <0+NRf>	Sets the current output calibration point (1 or 2). The actual output current is measured with the external meter.	N
:VOLTage		N
:CALCulate	Calculates the value of the gain and offset for output voltage.	N
:DAC <0+NR1>	Sets the output of the output voltage D/A converter. The value range is 0 - 4095.	N
:GAIN <NRf>	Sets the value of the gain for the output voltage.	N
:OFFSet <NRf>	Sets the value of the offset for the output voltage.	N
:POINt <1|2> <NRf>	Sets the voltage output calibration point (1 or 2). The actual output voltage is measured with the external meter.	N
:PROTection		N
:CALCulate	Calculates the value of the gain and offset for output voltage protection. This takes more than 30 seconds to complete. Use *ESE 1 and a serial poll to detect the completed operation.	N
:DAC <0+NR1>	Sets the output of the output voltage protection D/A converter. The value range is 0 - 4095.	N
:GAIN <NRf>	Sets the value of the gain for the output voltage protection.	N
:OFFSet <NRf>	Sets the value of the offset for the output voltage protection.	N
:STORe	Stores the calibration constants in non-volatile memory.	N
:UNLock <string>	Sets the non-volatile memory available to store calibration constants. The access string is "6867".	N

3.6 MEASURE SCPI Command Subsystem

3.6.1 MEASURE SCPI Command Summary

MEASure[n]
:CURRent?
:VOLTage?

3.6.2 MEASURE SCPI Command Reference

Command	Description	SCPI
MEASure[n]	Measure subsystem. n = 1-31. The default channel is 1.	C
:CURRent?	Returns the floating point value of the DC output current in amps.	C
:VOLTage?	Returns the floating point value of the DC output voltage in volts.	C

3.7 OUTPUT SCPI Command Subsystem

3.7.1 OUTPUT SCPI Command Summary

OUTPut[n]
:ISOLation <boolean>
:PROTection
:DELay <0+NRf>
:FOLD <0|1|2>
:SENSe <boolean>
:STATe <boolean>
:TRIPped?

3.7.2 OUTPUT SCPI Command Reference

Command	Description	SCPI
OUTPut[n]	Output subsystem. n = 1-31. The default channel is 1.	C

Command	Description	SCPI
:ISOLation <boolean>	Sets the rear panel isolation relay control signal ON or OFF. Valid arguments are 1/ON or 0/OFF.	N
:PROTection		N
:DELay <0+NRf>	Sets the programmable time delay executed by the supply before reporting output protection conditions after a new output voltage or current is specified.	N
:FOLD <0|1|2>	Sets the foldback mode of the supply. Valid arguments are 0 (OFF), 1 (Constant Voltage), or 2 (Constant Current).	N
:SENSe <boolean>	Sets the sense relay signal open or close. Valid arguments are 1/ON or 0/OFF.	N
:STATe <boolean>	Sets the output terminals opened or closed. Valid arguments are 1/ON or 0/OFF. *RST state value is ON. **WARNING**: a delay of 1 second is required after changing the relay state before any program is sent.	C
:TRIPped?	Returns the integer value 1 (TRIPPED) or 0 (UNTRIPPED) state of the output.	N

3.8 SOURCE SCPI Command Subsystem

3.8.1 SOURCE SCPI Command Summary

```
SOURce[n]
        :CURRent
                [:LEVel]
                        [:IMMediate]
                                [:AMPLitude] <0+NRf>
                        :TRIGgered
                                :CLEar
                                [:AMPLitude] <0+NRf>
                :LIMit
                        [:AMPLitude] <0+NRf>
                :RAMP <0+NRf> <0+NRf>
                        :ABORt
                        :ALL?
                        :TRIGgered <0+NRf> <0+NRf>
```

```
:ONLine?
:STATus
        :BLOCk?
        :REGister?
:TIMeout?
:VOLTage
        [:LEVel]
                [:IMMediate]
                        [:AMPLitude] <NRf>
                :TRIGgered
                        :CLEar
                        [:AMPLitude] <NRf>
        :LIMit
                [:AMPLitude] <NRf>
        :PROTection
                [:LEVel] <NRf>
                :TRIPped?
                :STATe?
        :RAMP <NRf> <0+NRf>
                :ABORt
                :ALL?
                :TRIGgered <NRf> <0+NRf>
```

3.8.2 SOURCE SCPI Command Reference

Command	Description	SCPI
SOURce[n]	Source subsystem. n = 1-31. The default channel is 1.	C
:CURRent	Sets the output current in amps (default) or in milliamps.	C
[:LEVel]	Sets the output current in amps (default) or in milliamps.	C
[:IMMediate]	Sets the output current in amps (default) or in milliamps.	C
[:AMPLitude] <0+NRf>	Sets the output current in amps (default) or in milliamps.	C
:TRIGgered	Sets the value of the output current to be implemented by the trigger.	C
:CLEar	Clears the trigger mode.	
[:AMPLitude] <0+NRf>	Sets the value of the output current to be implemented by the trigger.	C
:LIMit	Sets an upper soft limit on the programmed output current for the supply.	C

Command	Description	SCPI
[:AMPLitude] <0+NRf>	Sets an upper soft limit on the programmed output current for the supply.	C
:RAMP <0+NRf> <0+NRf>	Sets the output current to ramp from the present value to the specified value (first argument) in the specified time (second argument). See ramp description below.	N
:ABORt	Aborts ramping and clears trigger mode.	
:ALL?	Returns the ramping status of all channels.	
:TRIGgered <0+NRf> <0+NRf>	Sets the output current to ramp from the present value to the specified value (first argument) in the specified time (second argument) upon the trigger command. See ramp description below.	N
:ONLine?	Returns the integer value 1(ONLINE) or 0 (OFFLINE) of the channel online status.	N
:STATus		
:BLOCk?	Returns the block of data critical to the status of the channel: 1) channel number 2) online status 3) status flags register (see table below) 4) status register (see sect. **A1.2.2**) 5) accumulated status (see sect. **A1.2.2**) 6) fault mask register (see sect. **A1.2.2**) 7) fault register (see sect. **A1.2.2**) 8) error register (see sect. **A1.2.3**) 9) model serial number 10) model voltage 11) model current 12) model over-voltage 13) output voltage DAC gain 14) output voltage DAC offset 15) output current DAC gain 16) output current DAC offset 17) output voltage protection DAC gain 18) output voltage protection DAC offset 19) voltage measurement ADC gain 20) voltage measurement ADC offset 21) current measurement ADC gain 22) current measurement ADC offset 23) model string	N

Command	Description	SCPI
	24) OVP calibrated Each value is separated by commas.	
:REGister?	Returns the integer value of the status register. See section **A1.2.2**.	N
:TIMeout?	Returns the integer value 1 (timeout since last query) or 0 (no timeout) of the timeout status of the channel.	N
:VOLTage	Sets the output voltage of the supply in volts (default) or in millivolts. A negative value will cause the POLARITY relay output signal to close.	C
[:LEVel]	Sets the output voltage of the supply in volts (default) or in millivolts. A negative value will cause the POLARITY relay output signal to close.	C
[:IMMediate]	Sets the output voltage of the supply in volts (default) or in millivolts. A negative value will cause the POLARITY relay output signal to close.	C
[:AMPLitude] <NRf>	Sets the output voltage of the supply in volts (default) or in millivolts. A negative value will cause the POLARITY relay output signal to close.	C
:TRIGgered	Sets the value of the output voltage to be implemented by the trigger. A negative value will cause the POLARITY relay output signal to close.	C
:CLEar	Clears the trigger mode.	
[:AMPLitude] <NRf>	Sets the value of the output voltage to be implemented by the trigger. A negative value will cause the POLARITY relay output signal to close.	C
:LIMit	Sets the upper soft limit on the programmed output voltage.	C
[:AMPLitude] <NRf>	Sets the upper soft limit on the programmed output voltage.	C
:PROTection	Sets the over voltage protection trip point in volts (default) or in millivolts.	C
[:LEVel] <NRf>	Sets the over voltage protection trip point in volts (default) or in millivolts.	C

Command	Description	SCPI
:TRIPped?	Returns the integer value 1(TRIPPED) or 0 (UNTRIPPED) state of the over voltage protection.	C
:STATe?	Returns the integer value 1 (ON) or 0 (OFF) state of the over voltage protection.	C
:RAMP <NRf> <0+NRf>	Sets the output voltage to ramp from the present value to the specified value (first argument) in the specified time (second argument). See ramp description below.	N
:ABORt	Aborts ramping and clears trigger mode.	
:ALL?	Returns the ramping status of all channels.	
:TRIGgered <NRf> <0+NRf>	Sets the output voltage to ramp from the present value to the specified value (first argument) in the specified time (second argument) upon the trigger command. See ramp description below.	N

THE RAMP FUNCTION

The ramp function allows the user to transition from one voltage or current to another linearly in a specified time period (100 ms - 99 sec with 100 ms programming resolution). The ramp upon trigger function may be used to program different ramping parameters for several units then all begin their ramps at the same time. A unit may ramp only voltage or current, not both at a given time. For example, SOUR:VOLT:RAMP:TRIG 1 1 followed by SOUR:CURR:RAMP:TRIG 2 2 will cause the unit to ramp only the output current to 2 amps in 2 seconds upon the TRIG:RAMP command.

Voltage ramping to a higher voltage requires a programmed current of at least 20% of the full scale value. Settings less than 20% will significantly lengthen the ramp time due to charging of the large capacitance in the output section of the power supply.

Voltage ramping to a lower voltage requires an appropriate resistive load. The discharge rate of the large capacitance in the output section of the power supply, plus other user capacitance, significantly lengthens the ramp time.

Current ramping requires an appropriate resistive load.

SOURce[n]:STATus:BLOCk? "Status Flags" REGISTER			
Bit	**Hex Value**	**Name**	**Description**
0	0x001	remote mode	Remote mode was selected.
1	0x002	polarity signal	Negative voltage programmed. Polarity signal is on.
2	0x004	PON SRQ	PON Service Request selected by rear panel switch.
3	0x008	SRQ sent	GPIB Service Request issued and the serial poll has not been received.
4	0x010	EEPROM	The EEPROM is locked.
5	0x020	trip occurred	Either an OV or OT trip occurred.
6	0x040	sense signal	Sense signal is on.
7	0x080	isolation signal	Isolation signal is on.
8	0x100	hold	Voltage & current output waiting for trigger.
9	0x200	fold	Foldback protection is enabled.
10	0x400	SRQ enabled	Service Request generation is enabled.
11	0x800	output	Output is on.

3.9 STATUS SCPI Command Subsystem

3.9.1 STATUS SCPI Command Summary

STATus[n]
:OPERation
:CONDition?
:ENABle <0+NR1>
:EVENt?
:PRESet
:PROTection
:CONDition?
:ENABle <0+NR1>
:EVENt?
:QUEStionable
:CONDition?
:ENABle <0+NR1>
:EVENt?

3.9.2 STATUS SCPI Command Reference

Command	Description	SCPI
STATus[n]	Status subsystem. n = 1-31. The default channel is 1.	C
:OPERation		C
:CONDition?	Returns the integer value of the Operation Condition Register. The query is supported but will always return "0" indicating operational condition.	C
:ENABle <0+NR1>	Sets the enable mask of the Operation Event Register allowing true conditions to be reported in the summary bit of the Operation Condition Register. Values are written and queried but have no effect on the Operation Condition Register.	C
:EVENt?	Returns the integer value of the Operation Event Register. This query is supported but always returns a value of "0", indicating operational condition.	C
:PRESet	Sets the enable mask of the Operation Event Register and the Questionable Event Register to all 1's.	C
:PROTection		C
:CONDition?	Returns the integer value of the Protection Condition Register. See section **3.2.3**.	C
:ENABle <0+NR1>	Sets the enable mask of the Protection Event Register which allows true conditions to be reported in the summary bit of the Protection Condition Register.	C
:EVENt?	Returns the integer value of the Protection Event Register.	C
:QUEStionable		C
:CONDition?	Returns the integer value of the Questionable Condition Register. The query is supported but will always return "0" indicating operational condition.	C
:ENABle <0+NR1>	Sets the enable mask of the Questionable Event Register allowing true conditions to be reported in the summary bit of the Questionable Condition Register. Values are written and queried but have no effect on the Questionable Condition Register.	C

Command	Description	SCPI
:EVENt?	Returns the integer value of the Questionable Event Register. This query is supported but always returns a value of "0", indicating operational condition.	C

3.10 SYSTEM SCPI Command Subsystem

3.10.1 SYSTEM SCPI Command Summary

SYSTem
:ERRor?
:FAULt?
:VERsion?

3.10.2 SYSTEM SCPI Command Reference

Command	Description	SCPI
SYSTem	System subsystem.	C
:ERRor?	Queries Error Queue for next error/event entry (first in, first out). Entries conatins an error number and descriptive text. A 0 return value indicates no error occurred; negative numbers are reserved by SCPI. The maximum return string length is 255 characters. The queue holds up to 10 error/entries. All entries are cleared by the *CLS command.	C
:FAULt?	Returns four numeric values separated by commas for the four system fault registers. See System Fault Registers below. e.g. 1, 1, 2, 4 indicates ch 1, 9, 18, and 27 each have at least one fault. **Response:** <Fault1_8>, <Fault9_16>, <Fault17-24>, <Fault25-31>	N

Command	Description	SCPI
:VERsion?	Returns a numeric value corresponding to	C

	the SCPI version number for which the instrument complies. The response is in the format YYYY.V where the Y's represent the year and V represents the approved version number for that year. e.g. 1995.0	

SYSTEM FAULT REGISTERS: Fault1_8, Fault9_16, Fault17_24, Fault25_31					
Bit Position	**Bit Weight**	**Fault1_8**	**Fault9_16**	**Fault17_24**	**Fault25_31**
7	128	Channel 8	Channel 16	Channel 24	not used
6	64	Channel 7	Channel 15	Channel 23	Channel 31
5	32	Channel 6	Channel 14	Channel 22	Channel 30
4	16	Channel 5	Channel 13	Channel 21	Channel 29
3	8	Channel 4	Channel 12	Channel 20	Channel 28
2	4	Channel 3	Channel 11	Channel 19	Channel 27
1	2	Channel 2	Channel 10	Channel 18	Channel 26
0	1	Channel 1	Channel 9	Channel 17	Channel 25

SYSTEM FAULT REGISTERS

The M9C provides four System Fault Registers to allow the user to monitor the fault status of a multiple-channel system. For example, the user may poll these registers to quickly determine which channel generated an enabled GPIB service request.

The SYStem:FAULt? query returns 4 numeric values separated by commas. Each value is the decimal equivalent of the total bit weights for that System Fault Register as described in the table above.

3.11 TRIGGER SCPI Command Subsystem

3.11.1 TRIGGER SCPI Command Summary

TRIGger[n]
:ABORt
:RAMP
:TYPE <1|2|3>

3.11.2 TRIGGER SCPI Command Reference

Command	Description	SCPI
TRIGgered[n]	Trigger subsystem. n = 0, 1-31. The default channel is 1. A value of n = 0 will program all channels.	C
:ABORt	Clears all settings of voltage and current upon trigger.	N
:RAMP	Implements current or voltage ramping function previously programmed by the SOURce:CURRent:RAMP or SOURce:VOLTage:RAMP commands.	N
:TYPe<1|2|3>	Implements voltage and current values previously programmed by the SOURce:CURRent:LEVel:TRIGgered and SOURce:VOLTage:LEVel:TRIGgered commands. Valid arguments are 1 (Voltage), 2 (Current), or 3 (Both).	N

3.12 Examples of Using the SCPI Commands

The following examples demonstrate programming a power supply to control and to readback the output using the SCPI commands. The maximum voltage and current output is dependent on the particular model. The examples list only the SCPI commands; the code required to send the commands is dependent on the type of language you are using (e.g. C or BASIC) and GPIB hardware (e.g. National Instruments).

EXAMPLE: Program a unit with no load at the output to 5 VDC @ 1 A, and verify the output.

```
// Use SYST:ERR? after each command to verify no programming errors.
// power-on the unit.
*CLS              // clear the unit to its power-on default settings.
*RST              // reset the unit.
SOUR:CURR 1.0     // program output current to 1.0 A.
SOUR:CURR?        // confirm the output current setting (response: 1.0).
SOUR:VOLT 5.0     // program output voltage to 5.0 VDC.
SOUR:VOLT?        // confirm the output voltage setting (response: 5.0).
MEAS:CURR?        // measure the actual output current (response: ~ 0.0).
MEAS:VOLT?        // measure the actual output voltage (response: ~ 5.0).
```

EXAMPLE: Program a unit with no load at the output to generate a GPIB service request upon an over voltage protection trip condition. (Must use GPIB not RS-232.)

```
// Use SYST:ERR? after each command to verify no programming errors.
// assure that PON is not selected on the rear panel switch
// and the front panel SRQ led is OFF. Power-on the unit.
*CLS                    // clear the unit to its power-on default settings.
*RST                    // reset the unit.
SOUR:VOLT:PROT 4.0      // program the OVP trip point to 4.0 VDC.
SOUR:VOLT:PROT?         // confirm the OVP trip point setting (response: 4.0).
SOUR:CURR 1.0           // program output current to 1.0 A.
SOUR:VOLT 3.0           // program output voltage to 3.0 VDC.
STAT:PROT:ENABLE 8      // program the unit to report OVP trip.
STAT:PROT:ENABLE?       // confirm that OVP fault is enabled (response: 8).
*SRE 2                  // enable the GPIB service request upon a fault.
*SRE?                   // confirm the GPIB service request enabled (response 2).
STAT:PROT:EVENT?        // confirm no faults occurred (response: 0).
                        // confirm that the OVP led and SRQ led is not active.
SOUR:VOLT 7.0           // program output voltage to 7.0 VDC - cause OVP trip!
// confirm that OVP led and SRQ led is active, and unit issued a GPIB service request (use
a serial poll).
```

EXAMPLE: Program a unit with no load at the output to change its output voltage and current to 5 VDC @ 1A at the same time.

```
// Use SYST:ERR? after each command to verify no programming errors.
// power-on the unit.
*CLS                    // clear the unit to its power-on default settings.
*RST                    // reset the unit.
SOUR:CURR:TRIG1.0       // program output current to 1.0 A upon trigger.
SOUR:CURR:TRIG?         // confirm output current set to 1.0 A upon trigger.
SOUR:VOLT:TRIG5.0       // program output voltage to 5.0 VDC upon trigger
SOUR:VOLT:TRIG?         // confirm output current set to 5.0 VDC upon trigger.
MEAS:CURR?              // measure the actual output current (response: 0.0).
MEAS:VOLT?              // measure the actual output voltage (response: 0.0).
TRIG:TYPE 3             // trigger the unit to implement curr and volt programming.
MEAS:CURR?              // measure the actual output current (response: ~ 0.0).
MEAS:VOLT?              // measure the actual output voltage (response: ~ 5.0).
TRIG:ABORT              // turn off trigger mode.
```

EXAMPLE: Program a unit with no load at the output to ramp its output voltage from 5 VDC to 25 VDC in 30 seconds.

NOTE: *The maximum output voltage is dependent on the power supply.*

```
// Use SYST:ERR? after each command to verify no programming errors.
// power-on the unit.
*CLS                        // clear the unit to its power-on default settings.
*RST                        // reset the unit.
SOUR:CURR 33.0              // program output current to 33.0 A.
SOUR:VOLT 5.0               // program output voltage to 5.0 VDC.
SOUR:VOLT:RAMP 25.0 30.0    // program voltage to ramp from the present
                            // value (5.0 VDC) to 25.0 VDC in 30 seconds.
```

EXAMPLE: Program a unit with the output shorted to ramp its output current from 5 A to 25 A in 30 seconds.

```
// Use SYST:ERR? after each command to verify no programming errors.
// power-on with no load at the output.
*CLS                        // clear the unit to its power-on default settings.
*RST                        // reset the unit.
                            // short the output.
SOUR:VOLT 33.0              // program output current to 33.0 VDC.
SOUR:CURR 5.0               // program output voltage to 5.0 A.
SOUR:CURR:RAMP 25.0 30.0    // program voltage to ramp from the present
                            // value (5.0 A) to 25.0 A in 30 seconds.
```

EXAMPLE: Program a unit with no load at the output to ramp its output voltage from 5 VDC to 25 VDC in 30 seconds upon the trigger command.

```
// Use SYST:ERR? after each command to verify no programming errors.
// power-on the unit.
*CLS                              // clear the unit to its power-on default settings.
*RST                              // reset the unit.
SOUR:CURR 33.0                        // program output current to 33.0 A.
SOUR:VOLT 5.0                         // program output voltage to 5.0 VDC.
SOUR:VOLT:RAMP:TRIG 25.0 30.0         // program voltage to ramp from the present
                                      // value (5.0 VDC) to 25.0 VDC in 30 secs.
                                      // upon the trigger command.
TRIG:RAMP                             // start ramp execution.
TRIG:ABORT                            // turn off trigger mode.
```

EXAMPLE: Program a unit to power-on and initialize to 2 VDC @ 1 A with an over voltage protection level of 3 VDC. Verify proper power-on initialization.

```
// Use SYST:ERR? after each cmd to verify no programming errors.
// power-on the unit.
*CLS                        // clear the unit to its power on default settings.
*RST                        // reset the unit.
CAL:INIT:CURR 1.0           // set power-on initial current to 1.0 A.
CAL:INIT:CURR?              // confirm power-on initial current setting.
CAL:INIT:VOLT 2.0           // set power-on initial voltage to 2.0 VDC.
CAL:INIT:VOLT?              //.confirm power-on initial voltage setting.
CAL:INIT:VOLT:PROT 3.0 // set power-on initial over voltage protection to 3.0 VDC.
CAL:INIT:VOLT:PROT?     // confirm power-on initial over voltage protection setting.

// cycle power to the unit.
// note voltage is initialized to 2.0 VDC via front panel.
SOUR:CURR?              // confirm power-on initial current setting.
SOUR:VOLT?              // confirm power-on initial voltage setting.
SOUR:VOLT:PROT?         // confirm power-on initial over voltage protection setting.
```

4.0 CALIBRATION

4.1 Introduction

The M9C is calibrated to adjust internal signal levels to correspond to the expected supply output signal levels. You must perform the calibration procedures if the power supply's programming or readback performance falls out of specification due to component aging drifts. The M9C is calibrated for output voltage programming, output current programming, output over voltage protection programming, voltage readback, and current readback. There are 10 calibration factors (4 measurement and 6 output).

The calibration procedures in the following sections are designed to be performed an at ambient temperature of 25 °C ± 5 °C, after the unit has had a stable output and a stable load for at least 10 minutes.

The following test equipment is required in addition to the computer system to complete the following calibration:

- 6-digit digital voltmeter (DVM)
- current shunt rated for the full output current

WARNING

Please refer to the power supply manual for further information before performing any calibration procedures. Calibration must be performed by qualified personnel who are aware of properly dealing with attendant hazards.

4.2 Setup For Calibration

STEP DESCRIPTION

1. Disconnect the power supply's AC input power.

2. Disconnect the load from the power supply you want to calibrate.

3. Connect the power supply for sensing at the required load point. Refer to the power supply manual for further information.

4. Connect the DVM to the output for voltage or overvoltage calibration, or connect a current shunt rated for the full output current of the supply and the DVM for current calibration.

5. Assure the correct GPIB primary address has been set by the rear panel switch.

6. Set the power supply to REMOTE mode by the rear panel switch.

7. Connect the GPIB controller to the power supply at the rear panel connector.

8. Reconnect the AC input power. Turn the unit ON and allow the unit to warm up for at least 10 minutes.

9. The unit is ready for all calibration procedures.

WARNING

Exercise caution when using and servicing power supplies. High energy levels can be stored at the output voltage terminals on all power supplies in normal operation. In addition, potentially lethal voltages exist in the power circuit and the output connector power supplies which are rated at 40V and over. Filter capacitors store potentially dangerous energy for some time after power is removed.

4.3 Voltage Programming Calibration

STEP DESCRIPTION

1. Program the over voltage protection to maximum to prevent nuisance trips:

   CAL[n]:OUTP:VOLT:PROT:DAC 4095

2. Program the output current to full scale to prevent Constant-Current operation:

   CAL[n]:OUTP:CURR:DAC 4095

3. Program the output of the first calibration point to approximately 10% of full scale voltage by sending the following command string from the computer:

   CAL[n]:OUTP:VOLT:DAC 400

4. Let the output settle and measure the voltage with the meter.

5. Enter the actual output voltage corresponding to the DAC value 400 of the first calibration point:

   CAL[n]:OUTP:VOLT:POINT 1 <voltage>

6. Program the output of the second calibration point to approximately 90% of full scale voltage by sending the following command string from the computer:

   CAL[n]:OUTP:VOLT:DAC 3600

7. Let the output settle and measure the voltage with the meter.

8. Enter the actual output voltage corresponding to the DAC value 3600 of the second calibration point:

   CAL[n]:OUTP:VOLT:POINT 2 <voltage>

9. Reset the output voltage to 0 volts.

   CAL[n]:OUTP:VOLT:DAC 0

10. Program the M9C to calculate the output voltage calibration gain and offset values:

    CAL[n]:OUTP:VOLT:CALC

11. Program the M9C to unlock the non-volatile memory for calibration value storage:

    CAL[n]:UNLOCK "6867"

12. Program the M9C to store the calibration values in non-volatile memory:

    CAL[n]:STORE

13. Program the M9C to lock the non-volatile memory for calibration value protection

    CAL[n]:LOCK

14. The output voltage calibration is complete. The unit may be turned OFF or other calibration procedures may be performed.

4.4 Voltage Measurement/Readback Calibration

STEP DESCRIPTION

1. Program the over voltage protection to maximum to prevent nuisance trips:

   CAL[n]:OUTP:VOLT:PROT:DAC 4095

2. Program the output current to full scale to prevent Constant-Current operation:

   CAL[n]:OUTP:CURR:DAC 4095

3. Program the output of the first calibration point to approximately 10% of full scale voltage by sending the following command string from the computer:

   CAL[n]:OUTP:VOLT:DAC 400

4. Let the output settle and measure the voltage with the meter.

5. Enter the actual voltage readback corresponding to the DAC value 400 of the first calibration point:

   CAL[n]:MEAS:VOLT:POINT 1 <voltage>

6. Program the output of the second calibration point to approximately 90% of full scale voltage by sending the following command string from the computer:

   CAL[n]:OUTP:VOLT:DAC 3600

7. Let the output settle and measure the voltage with the meter.

8. Enter the actual voltage readback corresponding to the DAC value 3600 of the second calibration point:

   CAL[n]:MEAS:VOLT:POINT 2 <voltage>

9. Reset the output voltage to 0 volts.

   CAL[n]:OUTP:VOLT:DAC 0

10. Program the M9C to calculate the voltage readback calibration gain and offset values:

    CAL[n]:MEAS:VOLT:CALC

11. Program the M9C to unlock the non-volatile memory for calibration value storage:

    CAL[n]:UNLOCK "6867"

12. Program the M9C to store the calibration values in non-volatile memory:

    CAL[n]:STORE

13. Program the M9C to lock the non-volatile memory for calibration value protection

    CAL[n]:LOCK

14. The voltage readback calibration is complete. The unit may be turned OFF or other calibration procedures may be performed.

4.5 Over Voltage Protection Programming Calibration

The over voltage protection calibration procedure requires calibrated output voltage programming and voltage readback.

STEP DESCRIPTION

1. Program the M9C to self-calibrate the over voltage protection:

   CAL[n]:OUTP:VOLT:PROT:CALC

   The over voltage protection calibration function requires over 30 seconds. Use *ESE 1 and serial polls to detect when calibration is done.

2. Program the M9C to unlock the non-volatile memory for calibration value storage:

   CAL[n]:UNLOCK "6867"

3. Program the M9C to store the calibration values in non-volatile memory:

   CAL[n]:STORE

4. Program the M9C to lock the non-volatile memory for calibration value protection

   CAL[n]:LOCK

5. The output over voltage protection calibration is complete. The unit may be turned OFF or other calibration procedures may be performed.

4.6 Current Programming Calibration

STEP DESCRIPTION

1. Program the over voltage protection to maximum to prevent nuisance trips:

   CAL[n]:OUTP:VOLT:PROT:DAC 4095

2. Program the output voltage to full scale to prevent Constant-Voltage operation:

   CAL[n]:OUTP:VOLT:DAC 4095

3. Program the output of the first calibration point to approximately 10% of full scale current by sending the following command string from the computer:

   CAL[n]:OUTP:CURR:DAC 400

4. Let the output settle and measure the current with the current shunt and the meter.

5. Enter the actual output current corresponding to the DAC value 400 of the first calibration point:

   CAL[n]:OUTP:CURR:POINT 1 <current>

6. Program the output of the second calibration point to approximately 90% of full scale current by sending the following command string from the computer:

   CAL[n]:OUTP:CURR:DAC 3600

7. Let the output settle and measure the current with the current shunt and the meter.

8. Enter the actual output current corresponding to the DAC value 3600 of the second calibration point:

   CAL[n]:OUTP:CURR:POINT 2 <current>

9. Reset the output current to 0 amps.

   CAL[n]:OUTP:CURR:DAC 0

10. Program the M9C to calculate the output current calibration gain and offset values:

    CAL[n]:OUTP:CURR:CALC

12. Program the M9C to unlock the non-volatile memory for calibration value storage:

    CAL[n]:UNLOCK "6867"

13. Program the M9C to store the calibration values in non-volatile memory:

    CAL[n]:STORE

14. Program the M9C to lock the non-volatile memory for calibration value protection

    CAL[n]:LOCK

15. The output current calibration is complete. The unit may be turned OFF or other calibration procedures may be performed.

4.7 Current Measurement/Readback Calibration

STEP DESCRIPTION

1. Program the over voltage protection to maximum to prevent nuisance trips:

   CAL[n]:OUTP:VOLT:PROT:DAC 4095

2. Program the output voltage to full scale to prevent Constant-Voltage operation:

   CAL[n]:OUTP:VOLT:DAC 4095

3. Program the output of the first calibration point to approximately 10% of full scale current by sending the following command string from the computer:

   CAL[n]:OUTP:CURR:DAC 400

4. Let the output settle and measure the current with the current shunt and the meter.

5. Enter the actual current readback corresponding to the DAC value 400 of the first calibration point:

   CAL[n]:MEAS:CURR:POINT 1 <current>

6. Program the output of the second calibration point to approximately 90% of full scale current by sending the following command string from the computer:

   CAL[n]:OUTP:CURR:DAC 3600

7. Let the output settle and measure the current with the current shunt and the meter.

8. Enter the actual current readback corresponding to the DAC value 3600 of the second calibration point:

   CAL[n]:MEAS:CURR:POINT 2 <current>

9. Reset the output current to 0 amps.

   CAL:OUTP:CURR:DAC 0

10. Program the M9C to calculate the current readback calibration gain and offset values:

    CAL[n]:OUTP:CURR:CALC

11. Program the M9C to unlock the non-volatile memory for calibration value storage:

    CAL[n]:UNLOCK "6867"

12. Program the M9C to store the calibration values in non-volatile memory:

    CAL[n]:STORE

13. Program the M9C to lock the non-volatile memory for calibration value protection

    CAL[n]:LOCK

14. The current readback calibration is complete. The unit may be turned OFF or other calibration procedures may be performed.

4.8 Voltage Programming & Readback Calibration

This procedure may be used to save time if both the output and readback require calibration.

STEP DESCRIPTION

1. Program the over voltage protection to maximum to prevent nuisance trips:

   CAL[n]:OUTP:VOLT:PROT:DAC 4095

2. Program the output current to full scale to prevent Constant-Current operation:

   CAL[n]:OUTP:CURR:DAC 4095

3. Program the output of the first calibration point to approximately 10% of full scale voltage by sending the following command string from the computer:

   CAL[n]:OUTP:VOLT:DAC 400

4. Let the output settle and measure the voltage with the meter.

5. Enter the actual output voltage corresponding to the DAC value 400 of the first calibration point:

   CAL[n]:OUTP:VOLT:POINT 1 <voltage>
   CAL[n]:MEAS:VOLT:POINT 1 <voltage>

6. Program the output of the second calibration point to approximately 90% of full scale voltage by sending the following command string from the computer:

   CAL[n]:OUTP:VOLT:DAC 3600

7. Let the output settle and measure the voltage with the meter.

8. Enter the actual output voltage corresponding to the DAC value 3600 of the second calibration point:

   CAL[n]:OUTP:VOLT:POINT 2 <voltage>
   CAL[n]:MEAS:VOLT:POINT 2 <voltage>

9. Reset the output voltage to 0 volts.

CAL[n]:OUTP:VOLT:DAC 0

10. Program the M9C to calculate the output voltage and the voltage measurement calibration gain and offset values:

    CAL[n]:OUTP:VOLT:CALC
    CAL[n]:MEAS:VOLT:CALC

11. Program the M9C to unlock the non-volatile memory for calibration value storage:

    CAL[n]:UNLOCK "6867"

12. Program the M9C to store the calibration values in non-volatile memory:

    CAL[n]:STORE

13. Program the M9C to lock the non-volatile memory for calibration value protection

    CAL[n]:LOCK

14. The output voltage and voltage measurement calibrations are completed at the same time. The unit may be turned OFF or other calibration procedures may be performed.

4.9 Current Programming & Readback Calibration

This procedure may be used to save time if both the output and readback require calibration.

STEP DESCRIPTION

1. Program the over voltage protection to maximum to prevent nuisance trips:

   CAL[n]:OUTP:VOLT:PROT:DAC 4095

2. Program the output voltage to full scale to prevent Constant-Voltage operation:

   CAL[n]:OUTP:VOLT:DAC 4095

3. Program the output of the first calibration point to approximately 10% of full scale current by sending the following command string from the computer:

   CAL[n]:OUTP:CURR:DAC 400

4. Let the output settle and measure the current with the current shunt and the meter.

5. Enter the actual output current corresponding to the DAC value 400 of the first calibration point:

   CAL[n]:OUTP:CURR:POINT 1 <current>
   CAL[n]:MEAS:CURR:POINT 1 <current>

6. Program the output of the second calibration point to approximately 90% of full scale current by sending the following command string from the computer:

   CAL[n]:OUTP:CURR:DAC 3600

7. Let the output settle and measure the current with the current shunt and the meter.

8. Enter the actual output current corresponding to the DAC value 3600 of the second calibration point:

   CAL[n]:OUTP:CURR:POINT 2 <current>
   CAL[n]:MEAS:CURR:POINT 2 <current>

9. Reset the output current to 0 amps.

CAL[n]:OUTP:CURR:DAC 0

10. Program the M9C to calculate the output current and current measurement calibration gain and offset values:

    CAL[n]:OUTP:CURR:CALC
    CAL[n]:MEAS:CURR:CALC

12. Program the M9C to unlock the non-volatile memory for calibration value storage:

    CAL[n]:UNLOCK "6867"

13. Program the M9C to store the calibration values in non-volatile memory:

    CAL[n]:STORE

14. Program the M9C to lock the non-volatile memory for calibration value protection

    CAL[n]:LOCK

15. The output current and current measurement calibrations are completed at the same time. The unit may be turned OFF or other calibration procedures may be performed.

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A1 M9A COMMAND OPERATION

A1.1 Introduction

The following sections describe the operation of the M9C by remote programming using the M9A command set.

The M9A command set of programming, query, and status commands allow control of the power supply. Both GPIB and RS-232 are supported with the exception of Service Request (SRQ) which is a GPIB-specific implementation.

A1.2 M9A GPIB Register Definitions

A1.2.1 Status Byte and the Serial Poll Operation

The supply responds to a GPIB serial poll with the 8-bit Status Byte defined as follows:

STATUS BYTE REGISTER			
Bit Position	**Decimal Weight**	**Description**	**Reset By**
7 (MSB)	128	Power ON (PON) - Set when the supply initializes at power on.	CLR or Device clear.
6	64	Request Service (SRQ) - Set when the supply requests service.	Serial poll.
5	32	Error (ERR) - Set when the ERR bit is asserted in the Status Register.	ERR? query.
4	16	Ready - Set when the supply is ready to accept commands.	Power supply during command processing period.
3	8	Not used.	
2	4	Not used.	
1	2	Not used.	
0 (LSB)	1	Fault - Set when any bit in the fault register is set by a fault condition in the supply.	FAULT? query.

A1.2.2 Status, Accumulated Status, Fault, and Mask Registers

The Status, Accumulated Status, Fault, and Mask Registers share the same bit map. Each register describes an operating condition of the supply. The Status Register describes the current status of the supply. The Accumulated Status Register records the history of the supply status. The Fault Register records the condition that occurred enabled by the Mask Register.

STATUS AND FAULT REGISTERS			
Condition	**Mnemonic**	**Bit Position**	**Bit Weight**
Remote programming error	ERR	7	128
Foldback mode operation	FOLD	6	64
Supply external shutdown active (J7-1)	SD	5	32
Overtemperature protection tripped	OT	4	16
Overvoltage protection tripped	OV	3	8
Not used	---	2	4
Constant current operation	CC	1	2
Constant voltage operation	CV	0	1

Notes:

1. Only CV,CC,OV,OT,SD,ERR, and FOLD can be MASKed or UNMASKed.
2. The error (ERR) bit is reset with an error query (ERR?).
3. The accumulated status register is cleared with an accumulated status query (ASTS?).
4. A fault is cleared with a fault query (FAULT?).

A1.2.3 Error Register

ERROR REGISTER		
Error #	**Error Identification**	**Explanation**
0	No errors	
1	Unrecognized character	A character such as @ or $ was received.
2	Not used	
3	Not used	
4	Syntax error	An unrecognized command or data type was encountered. e.g. AAA
5	Number out of range	A number received for the command was outside of the allowed range. e.g.: VSET 900
6	Attempt to exceed soft limits	An attempt was made to program a voltage or current greater than the soft limit. e.g.: VMAX 500V; VSET 550V
7	Improper soft limit	An attempt was made to program a soft limit less than the output value. e.g.: VSET 5; VMAX 3
8	Not used	
9	OVP set below output	An OVSET command was sent with a trip value lower than the output voltage. e.g.: VSET 5; OVSET 3

A1.3 M9A Command Subsystem Reference

The M9A commands provide control in 4 categories:

- id control
- initialization control
- output control
- status and fault control

ID CONTROL	
Commands	**Description**
ID?	Returns the power supply model and the firmware version as an ASCII string. **Response:** ID <model name> <version> **Example:** ID DCS33-33 Version 1.00

The ID? query is a safe command to initially verify communications since it does not affect the unit in the other categories.

INITIALIZATION CONTROL	
Commands	**Description**
CLR	Initializes the supply to its Power ON (PON) condition. Resets the PON bit (position 7) in the Serial Poll Register.
RST	Resets the supply to present voltage and current settings if the output is disabled by overvoltage or foldback protection. Output values may be changed via VSET, ISET, and OVSET while the unit is disabled but will not take effect until RST is used.

Use the Initialization Control commands to clear an over-voltage fault condition or to set the unit to the known safe power-on default settings state.

OUTPUT CONTROL	
Commands	**Description**
HOLD <boolean>	Enables or disables voltage and current setting hold mode. When HOLD ON is specified, hold mode is enabled so that all voltage and current settings which normally be implemented by the supply are held until a trigger (TRG) command is received. This allows you to synchronize the operation of several supplies. **Initial value:** HOLD 0 (OFF)
HOLD?	Returns the integer value of the present hold mode setting. **Response:** HOLD <mode> where mode is: 0 (OFF or disabled) or 1 (ON or enabled)
IOUT?	Returns the floating point value of the actual current output measured using the built-in current readback A/D converter. **Response:** IOUT <0+NRf>

Commands	Description
IMAX <0+NRf>	Sets the upper soft limit on the programmed output current. If the soft limit is exceeded or if the soft limit value is lower than the present output current setting, the supply will ignore the command, turn on the ERR LED, and set the ERR bit in the Status and Serial Poll Registers. **Range:** 0 to model maximum output current **Initial value:** model maximum current
IMAX?	Returns the floating point value of the soft current limit setting. **Response:** IMAX <0+NRf>
ISET <0+NRf>	Sets the output current in amps (default) or in milliamps. This programmed current is the actual output in CC mode or the current limit in Constant-Voltage mode. **Range:** 0 to model maximum output current (IMAX) **Initial value:** 0 amps
ISET?	Returns the floating point value of the present output current setting. Does not apply to current settings which are being held (see HOLD). **Response:** ISET <0+NRf>
OUT <boolean>	Enables or disables voltage and current output. The supply will continue to accept new commands while the output is disabled but these will not be implemented until OUT ON or OUT 1 is received. OUT OFF or OUT 0 also sets the isolation signal on the rear panel J7 connector line 3 which may be used to trip external relays to isolate the supply from the load. **Initial value:** OUT 1 (ON or output enabled)
OUT?	Returns the integer value of the present enabled/disabled status of the output voltage and current. **Response:** OUT <mode> where mode is: 0 (OFF or disabled) or 1 (ON or enabled)
TRG	Implements the programmed voltage and current settings which had been in hold mode. The supply operates with previous values until the trigger (TRG) command is received.

Commands	Description
VMAX <NRf>	Sets the upper soft limit on the programmed output voltage. If the soft limit is exceeded or if the soft limit value is lower than the present output voltage setting, the supply will ignore the command, turn on the ERR LED, and set the ERR bit in the Status and Serial Poll Registers. **Range:** 0 to model maximum output voltage **Initial value:** model maximum voltage
VMAX?	Returns the floating point value of the soft voltage limit setting. **Response:** VMAX <NRf>
VOUT?	Returns the floating point value of the actual voltage output measured using the built-in voltage readback A/D converter. **Response:** VOUT <NRf>
VSET <NRf>	Sets the output voltage in volts (default) or in millivolts. This programmed voltage is the actual output in CV mode or the voltage limit in Constant-Current mode. **Range:** 0 to model maximum output voltage (VMAX) **Initial value:** 0 volts
VSET?	Returns the floating point value of the present output voltage setting. Does not apply to voltage settings which are being held (see HOLD command). **Response:** VSET <NRf>

Use the Output Control commands to set the output conditions of the unit:

- the output may be enabled or disabled,
- the output current and voltage levels may be set and queried,
- the output current and voltage may be measured,
- the output current and voltage change may be synchronized, and
- the output current and voltage level limits may be set and queried.

STATUS AND FAULT CONTROL	
Command	**Description**
ASTS?	Returns the integer value of the Accumulated Status Register. The Accumulated Status Register stores any bit that was entered in the Status Register since the Accumulated Status query command (ASTS?) was last used (if at all) regardless of whether the condition still exists. The Accumulated Status Register has the same bits, weights, and conditions as the Status Register. A bit in the Accumulated Status Register will be set to 1 if the corresponding bit in the Status Register has been 1 (TRUE) at any time since the register was last read. **Response:** ASTS <status mask> where status mask is the decimal equivalent of the total bit weights for the operating conditions as listed in the Status Register.
DLY <0+NRf>	Sets the programmable time delay before reporting fault conditions after a new output voltage or current is specified (VSET, ISET) or RST,TRG, or OUT ON commands are received. During delay time, the power supply disabled CV, CC, and FOLD conditions from generating faults, preventing possible nuisance foldback or service requests if the supply momentarily switches modes while changing an output setting. **Range:** 0 to 32 seconds, with 1 ms resolution. **Initial value:** 0.5 seconds
DLY?	Returns the floating point value of the programmable delay time setting before reporting fault conditions. **Response:** DLY <0+NRf>
ERR?	Returns the integer value of the most recent remote programming errors which occurred since the last time the error query (ERR?) was issued. When the supply detects a programming error, it sets the ERR bit in the Status and Fault Registers which can be unmasked (UNMASKed) on the Fault Register to request service. The remaining portion of the command line is discarded. An error query or a new, error-free, command clears the ERR bit in both the Status Register and the Serial Poll Register. **Response:** ERR <0+NRf>

Commands	Description
FAULT?	Returns the integer value of the Fault Register for the fault condition status. When a bit is set in the Fault Register, the rear panel J7 connector Fault Line 4 is also asserted. The Fault Line from any supply in the system may be tied to the External Shutdown Line J7-1 of all supplies to provide shutdown of the system, independent of the GPIB, for user-defined faults. The FAULT? query clears bits in the supply's Fault Register and fault lines. **Response:** FAULT <fault mask> where fault mask is the decimal equivalent of the total bit weights for the operating conditions as listed in the Fault Register.
FOLD <OFF|CV|CC> or FOLD <0|1|2>	Sets the foldback mode. Foldback protection disables the supply output when the output enters the foldback condition. Reset with the RST command. For example, specify FOLD CV or FOLD 1 for the supply to operate in Constant Current mode and have foldback protection disable the output if the supply switches to Constant Voltage mode. **Initial value:** FOLD 0 (OFF).
FOLD?	Returns the integer value of the present foldback mode setting. **Response:** FOLD <mode> where mode is: 0 (OFF), or 1 (CV or Constant Voltage mode), or 2 (CC or Constant Current mode)
MASK <mnemonics>	Disables the specified supply's operating conditions from reporting fault conditions in the Fault and Status Registers. Mnemonics are separated from each other by commas, and may be sent in any order. **MASK mnemonics:** CV (Constant Voltage), CC (Constant Current) OV (Over Voltage Protection) OT (Over Temperature Protection) SD (Shutdown) FOLD (Foldback) NONE (all conditions enabled) ALL (all conditions disabled) **Initial value:** MASK ALL

Commands	Description
OVSET <NRf>	Sets the overvoltage protection trip point in volts (default) or in millivolts. **Range:** 0 to 110% of model maximum output voltage (VMAX) **Initial value:** 110% of model maximum voltage
OVSET?	Returns the floating point value of the present overvoltage protection limit. **Response:** OVSET <0+NRf>
SRQ <boolean>	SRQ ON enables/disables the supply to respond to a variety of fault conditions by generating an IEEE-488 GPIB service request. With SRQ ON, the SRQ line will be asserted true whenever the FAU bit in the Serial Poll Register changes from 0 to 1. Therefore, the mask register, in addition to specifying which conditions set the FAU bit, also determines which conditions can generate service requests. Seven (7) supply conditions are defined as faults: CV, CC, OV, OT, SD, FOLD, and PON. User the FAULT? query to discover which condition caused the service request except for PON. A request for service at Power ON (PON) is set via the rear panel switch on the supply. SRQ remains disabled until the FAU bit in the Serial Poll Register is cleared by a FAULT? query. **Initial value:** SRQ 0 (OFF)
SRQ?	Returns the integer value of the present enabled/disabled status to generate GPIB service requests. **Response:** SRQ <mode> where mode is: 0 (disabled) or 1 (enabled)
STS?	Returns the integer value of the present Status Register. Status conditions are stored in the 8-bit Status Register. Each bit represents a separate condition. When the condition is true, the corresponding bit is 1. Bits remain set in the Status Register as long as the condition is true. **Response:** STS <status mask> where status mask is the decimal equivalent of the total bit weights for the operating conditions as listed in the Status Register.

Commands	Description
UNMASK <mnemonics>	Enables the specified operating conditions for fault occurrence. Mnemonics are separated from each other by commas and may be sent in any order. Specifying one or more mnemonics which describe the conditions (or the decimal equivalent of their total bit weight) enables the selected conditions to set bits in the Fault and Status Registers. A bit is set in the Fault Register when the corresponding bit in the Status Register changes from 0 to 1 and the corresponding bit the Mask Register is 1. Whenever any bit is set in the Fault Register, the FAU bit (position 0 is set in the Serial Poll Register. **UNMASK mnemonics:** CV (Constant Voltage), CC (Constant Current) OV (Over Voltage Protection) OT (Over Temperature Protection) SD (Shutdown) FOLD (Foldback) NONE (all conditions disabled) ALL (all conditions enabled) **Initial value:** UNMASK NONE
UNMASK?	Returns the integer value of the fault conditions currently enabled (UNMASKed). **Response:** UNMASK <fault mask> where fault mask is the decimal equivalent of the total bit weights for the operating conditions as listed in the Status and Fault Registers.

The Status And Fault Control commands to monitor the operating condition of the unit:

- CV (Constant Voltage operation),
- CC (Constant Current operation),
- OV (Over Voltage Protection tripped),
- OT (Over Temperature Protection tripped),
- SD (Shutdown active),
- FOLD (Foldback mode operation),
- ERR (Remote programming error)

The value of the over-voltage trip point may be set and queried. The foldback condition to monitor may be selected and queried. Enabled fault conditions will generate a GPIB service request if enabled. The most recent programming error may be queried.

A1.4 Examples of Using the M9A Commands

The following examples demonstrate programming control and to readback the output using the M9A commands. The maximum voltage and current output is dependent on the particular model. The examples list only the M9A commands; the code required to send the commands is dependent on the type of language you are using (e.g. C or BASIC) and GPIB hardware (e.g. National Instruments).

EXAMPLE: Program a unit with no load at the output to 5 VDC @ 1 A, and verify the output.

```
// Use ERR? after each command to verify no programming errors.
// power-on the unit.
CLR             // clear the unit to its power-on default settings.
RST             // reset the unit.
ISET 1.0        // program output current to 1.0 A.
ISET?           // confirm the output current setting. (response: ISET 1.000)
VSET 5.0        // program output voltage to 5.0 VDC.
VSET?           // confirm the output voltage setting. (response: VSET 5.000)
IOUT?           // measure the actual output current (response:  IOUT ~0.000).
VOUT?           // measure the actual output voltage (response: VOUT ~5.000).
```

EXAMPLE: Program a unit with no load at the output to generate a GPIB service request upon an over voltage protection trip condition. (Must GPIB not RS-232.)

```
// Use ERR? after each command to verify no programming errors.
// assure that PON is not selected in the rear panel switch
// and the front panel SRQ led is OFF.  Power-on the unit.
CLR             // clear the unit to its power-on default settings.
RST             // reset the unit.
OVSET 4.0       // program the OVP trip point to 4.0 VDC.
OVSET?          // confirm the OVP trip point setting (response: OVSET 4.000).
ISET 1.0        // program output current to 1.0 A.
VSET 3.0        // program output voltage to 3.0 VDC.
UNMASK OV       // program the unit to report OVP trip.
UNMASK?         // confirm that OVP fault is enabled (response: UNMASK 8).
SRQ 1           // enable the GPIB service request upon a fault.
SRQ?            // confirm the GPIB service request enabled (response: SRQ 1).
FAULT?          // confirm no faults occurred (response: FAULT 0).
                // confirm that the front panel OVP led and SRQ led is not active.
VSET 7.0        // program output voltage to 7.0 VDC - cause OVP trip!
                // confirm that the front panel OVP led and SRQ led is active, and
                // the unit issued a GPIB service request (use a serial poll).
```

EXAMPLE: Program a unit with no load at the output to change its output voltage and current to 5 VDC @ 1A at the same time.

```
// Use ERR? after each command to verify no programming errors.
// power-on the unit.
CLR             // clear the unit to its power-on default settings.
RST             // reset the unit.
HOLD 1          // program the unit to hold changes until TRG received.
HOLD?           // confirm that hold is enabled (response: HOLD 1).
ISET 1.0        // program output current to 1.0 A upon TRG.
VSET 5.0        // program output voltage to 5.0 VDC upon TRG.
IOUT?           // measure the actual output current (response:  IOUT ~0.000).
VOUT?           // measure the actual output voltage (response:  VOUT ~0.000).
TRG             // trigger the unit to implement ISET and VSET.
IOUT?           // measure the actual output current (response:  IOUT ~0.000).
VOUT?           // measure the actual output voltage (response:  VOUT ~5.000).
HOLD 0          // turn off hold mode.
```

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A2 OPERATION WITH M85 OPTION

A2.1 Introduction

The following sections describe the operation of the DCS power supply with the M85 option and how to configure the option for your application. The M85 option is installed at the factory.

The M85 option enables you to use your DCS Series power supply as an auxiliary unit. The master unit would be a DCS power supply with the M9C interface option. Both IEEE-488.2 and RS-232 are supported, and the auxiliary unit or units share the GPIB address or RS-232 interface with the master unit. Up to 30 auxiliary units can be controlled by the master unit.

This option can be used with the 1 k W and 3 k W supplies and supports the SCPI language. Refer to the M9C addendum, A1, above, for programming information.

A2.2 Configuration

The DIP switch S1, represented in Figure A2-1, is accessible from the rear panel. It allows configuration of the M85 for auxiliary operation. The figure shows the settings for the M85 configured as an auxiliary at channel 2, in remote mode, with no SRQ generated upon initialization.

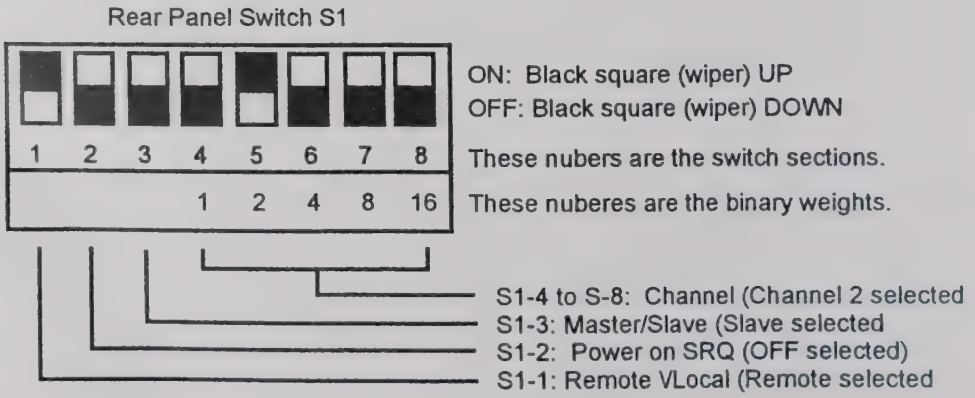
Rear Panel Switch S1
ON: Black square (wiper) UP
OFF: Black square (wiper) DOWN
1 2 3 4 5 6 7 8
These nubers are the switch sections.
1 2 4 8 16
These nuberes are the binary weights.
S1-4 to S-8: Channel (Channel 2 selected
S1-3: Master/Slave (Slave selected
S1-2: Power on SRQ (OFF selected)
S1-1: Remote VLocal (Remote selected

Figure A2-1. Auxiliary at Channel 2 in Remote Mode—No SRQ at Initialization

See Table A2-1 for definitions of all S1 switch settings:

Table A2-1. Definitions of S1 Switch Settings

Switch	ON	OFF
S1-1	Remote control	Local control
S1-2	PON SRQ ON. Generates GPIB service request to computer/controller when the power supply initializes upon first communication. The front panel SRQ LED will also turn ON. Issuing a serial poll clears service request and turns OFF LED.	Disables GPIB service request upon initialization.
S1-3	Not applicable. Must be OFF.	Unit operates as an auxiliary unit.
S1-4–8	Set channel number for unit in binary:	(Channels 0 & 1 see note below.)
S1-4:	Binary 1 ON	Binary 1 OFF
S1-5:	Binary 2 ON	Binary 2 OFF
S1-6:	Binary 4 ON	Binary 4 OFF
S1-7:	Binary 8 ON	Binary 8 OFF
S1-8:	Binary 16 ON	Binary 16 OFF

Note: *Channel numbers 0 and 1 are invalid for any auxiliary device, because the SCPI language reserves channel 0 for the "global" address to address all channels, and it reserves channel number 1 as the default number for the master channel with the M9C option.*

A2.3 System Installation

Follow the steps below, illustrated in Figure A1-2, to install the configured M85 into your system:

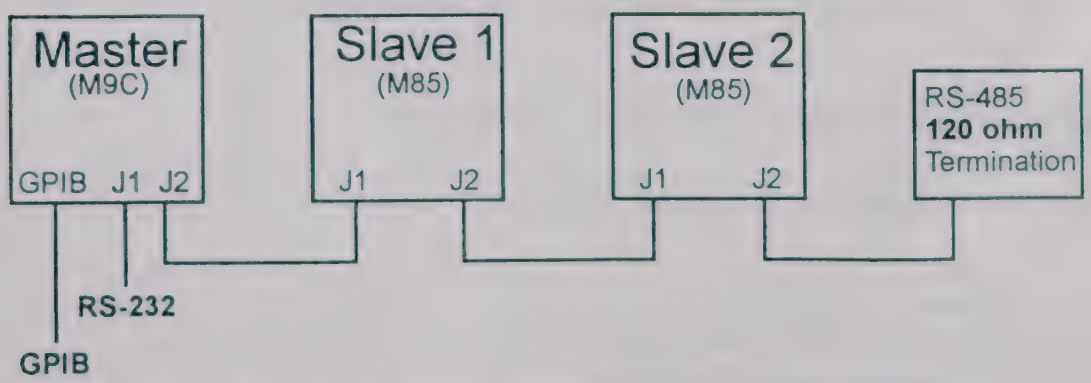

Figure A2-2. RS-485 System Interconnection with Two Auxiliaries

1. Configure the M85 as described in the Configuration section above.

2. Connect the master unit's RS-485 output connector, J2, to the auxiliary unit's RS-485 input connector, J1, using the modular cable.

3. If there are additional auxiliary units, connect the installed auxiliary unit's RS-485 output connector, J2, to the additional auxiliary unit's RS-485 input connector, J1, using the modular cable.

4. Connect the 120 ohm resistive termination assembly to the last auxiliary unit's J2 connector.

5. Connect power to the system, power it up, and verify that the green REMOTE LED on the front panel is ON.

6. Test the link by communicating with the auxiliary unit from the master unit, using the ***IDN[n]?** command. *Note that [n] is the channel number—for example, ***IDN2?** calls channel 2. (In response to this string, the system returns the power supply mode and the firmware version.)*

A2.4 RS-485 Interface

The RS-485 interface is accessible through the two rear-panel, 6-pin, RJ-11 connectors, J1 and J2, depicted in Figure A2-3.

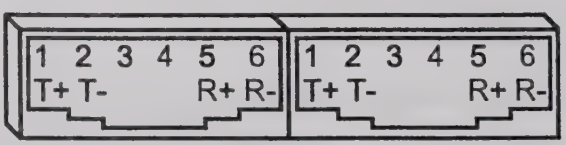

Figure A2-3. M85 Rear Panel RS-485 Connectors Pinout

A2.5 Programming the M85 Unit (Example)

The following example programs the M85 unit to—

- Power on
- Initialize to 2 V dc, at 1 A
- Set overvoltage protection level at 3 V dc
- Verify proper power-on initialization
- Save and store changes.

// Use SYST:ERR? after each cmd to verify no programming errors.
// power on the unit.

```
*CLS                        // clear the unit to its power on default settings.
*RST                        // reset the unit.
CAL:INIT:CURR 1.0           // set power-on initial current to 1.0 A.
CAL:INIT:CURR?              // confirm power-on initial current setting.
CAL:INIT:VOLT 2.0           // set power-on initial voltage to21.0 A.
CAL:INIT:VOLT?              // confirm power-on initial voltage setting.
CAL:INIT:VOLT:PROT 3.0      // set power-on initial over voltage protection to 3.0 A.
CAL:INIT:VOLT:PROT?         // confirm power-on initial over voltage protection setting.
CAL[n]:UNLOCK "6867"        // unlock nonvolatile memory for calibration value storage.
CAL[n]:STORE                // store the calibration values in nonvolatile memory.
CAL[n]:LOCK                 // lock nonvolatile memory for calibration value protection.
// cycle power to unit.
// note voltage is initialized to 2.0 V dc via front panel.
SOUR:CURR?                  // confirm power-on initial current setting.
SOUR:VOLT?                  // confirm power-on initial voltage setting.
SOUR:VOLT:PROT?             // confirm power-on initial over voltage protection setting.
```

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